polymer **206** and a common electrode disposed on the bottom side (not shown). Each electrode **202***a-g* resembles a letter, as shown.

[**0100**] Actuation of an active area corresponding to each electrode **202***a-g* causes surfaces features **210** on surface **204** to become visible. **FIG. 3E** illustrates actuation of one letter. More specifically, actuation of an active area corresponding to electrode **202***a* causes the letter 'a' to increase in planar size and depress into polymer **206** corresponding to the thinning of polymer **206**, thus creating an electrode surface feature **210***a* below the polymer thickness. In addition, actuation of an active area corresponding to electrode **202***a* causes the letter 'a'-shaped electrode **202***a* to increase in planar size and forces polymer **206** bordering the expanded electrode **202***a* to elevate and create a ridge polymer surface feature **212***a* about the electrode **202***a*. Electrode **202***a* is thus configured in surface area to affect a surface shape for recessed electrode surface feature **210***a* and elevated surface feature **212***a*.

[**0101**] Electrodes **202***a-g* and their corresponding active areas and surfaces features may be independently controlled. Thus, in conjunction with suitable control electronics, electrodes **202***a-c* and their respective active areas and surface features may be actuated simultaneously to create polymer surface features that spell a word. Other letters may be patterned to create customized visual words and outputs.

[**0102**] The present invention is not limited to simple square or rectangular geometric shapes. Other shapes (circles, triangles, etc.) or complex patterns may be generated with the present invention. For instance, electrodes may be patterned for logos, line drawings, etc. In another embodiment the squares of **FIG. 3A** may be individually patterned and controlled to generate different surface feature outputs.

[**0103**] **FIG. 3F** illustrates a side view of grid surface features for a transducer **260** in accordance with another specific embodiment of the present invention. A non-compliant electrode **262** is mounted to a rigid structure **264**. A passive layer **266** is mounted on top surface of polymer **268**. On a top surface of polymer **268** is a grid of thin conductive strips **270**, such as a metal wires. When polymer **268** is actuated, the conductive wires **270** cut into polymer **268** causing polymer **268** to bulge around the wires **270**. Bulging surface polymer features **269** in polymer **268** cause corresponding bulging surface features **267** in passive layer **266**. For instance, in one embodiment, the metal wires **270** are laid out in a grid in a diamond pattern like a quilt and when the polymer **268** is actuated the passive layer **266** exhibits a quilted pattern on the surface of passive layer **266**.

5. MULTIFUNCTIONALITY

[**0104**] Electroactive polymers may convert between electrical energy and mechanical energy in a bi-directional manner. Sensing electrical properties of an electroactive polymer transducer also permits sensing functionality.

[**0105**] **FIGS. 1A and 1B** may be used to show one manner in which the transducer portion **10** converts mechanical energy to electrical energy. For example, if the transducer portion **10** is mechanically stretched by external forces to a thinner, larger area shape such as that shown in **FIG. 1B**, and a relatively small voltage difference (less than that necessary to actuate the film to the configuration in **FIG. 1B**) is applied between electrodes **14** and **16**, the transducer portion **10** will contract in area between the electrodes to a shape such as in **FIG. 1A** when the external forces are removed. Stretching the transducer refers to deflecting the transducer from its original resting position—typically to result in a larger net area between the electrodes, e.g. in the plane defined by directions **18** and **20** between the electrodes. The resting position refers to the position of the transducer portion **10** having no external electrical or mechanical input and may comprise any pre-strain in the polymer. Once the transducer portion **10** is stretched, the relatively small voltage difference is provided such that the resulting electrostatic forces are insufficient to balance the elastic restoring forces of the stretch. The transducer portion **10** therefore contracts, and it becomes thicker and has a smaller planar area in the plane defined by directions **18** and **20** (orthogonal to the thickness between electrodes). When polymer **12** becomes thicker, it separates electrodes **14** and **16** and their corresponding unlike charges, thus raising the electrical energy and voltage of the charge. Further, when electrodes **14** and **16** contract to a smaller area, like charges within each electrode compress, also raising the electrical energy and voltage of the charge. Thus, with different charges on electrodes **14** and **16**, contraction from a shape such as that shown in **FIG. 1B** to one such as that shown in **FIG. 1A** raises the electrical energy of the charge. That is, mechanical deflection is being turned into electrical energy and the transducer portion **10** is acting as a generator.

[**0106**] In some cases, the transducer portion **10** may be described electrically as a variable capacitor. The capacitance decreases for the shape change going from that shown in **FIG. 1B** to that shown in **FIG. 1A**. Typically, the voltage difference between electrodes **14** and **16** will be raised by contraction. This is normally the case, for example, if additional charge is not added or subtracted from electrodes **14** and **16** during the contraction process. The increase in electrical energy, U, may be illustrated by the formula $U=0.5\ Q^2/C$, where Q is the amount of positive charge on the positive electrode and C is the variable capacitance which relates to the intrinsic dielectric properties of polymer **12** and its geometry. If Q is fixed and C decreases, then the electrical energy U increases. The increase in electrical energy and voltage can be recovered or used in a suitable device or electronic circuit in electrical communication with electrodes **14** and **16**. In addition, the transducer portion **10** may be mechanically coupled to a mechanical input that deflects the polymer and provides mechanical energy.

[**0107**] Electroactive polymers of the present invention may also be configured as a sensor. Generally, an electroactive polymer sensor detects a "parameter" and/or changes in the parameter. The parameter is usually a physical property of an object such as strain, deformation, velocity, location, contact, acceleration, vibration, pressure, size, etc. In some cases, the parameter being sensed is associated with a physical "event". The physical event that is detected may be the attainment of a particular value or state for example. An electroactive polymer sensor is configured such that a portion of the electroactive polymer deflects in response to the change in a parameter being sensed. The electrical energy state and deflection state of the polymer are related. The change in electrical energy or a change in the electrical impedance of an active area resulting from the deflection may then be detected by sensing electronics in electrical